

[0011]

Additionally, preferably, the throttle body has a motor housing in which a motor is disposed. Formed in the motor housing is a substantially circular indentation that receives, with clearance, a shaft portion provided at the other axial end portion of the motor casing. The support member is interposed between the shaft portion and an inner peripheral surface of the substantially circular indentation.

[0012]

Further, it is advantageous if the shaft portion protrudes from the other axial end surface of the motor casing, and the outer diameter of the shaft portion is smaller than the outer diameter of the motor casing. This construction makes the second support device compact.

[0013]

Further, it is preferable for the support member to be disposed between the other axial end surface of the motor casing and a support surface provided within the circular indentation so as to be axially opposed to the end surface of the motor casing. This arrangement makes it possible to support the other axial end portion of the motor casing on the motor housing resiliently with respect to the axial direction of the motor.

[0014]

According to a second aspect of the present invention, there is provided a method of mounting a motor to a throttle body in the throttle control device described above. This method includes the following steps: a) attaching the support member to the other end portion of the motor casing of the motor; b) inserting the motor into the throttle body, starting with the other end portion with the support member attached thereto, whereby the other axial end portion of the motor casing is supported by the throttle body resiliently with respect to the

radial direction of the motor via the second support device; and c) fixing the end portion of the motor casing to the throttle body via the first support device.

[0015]

In this method, it is possible to affect the resilient support by the second support device through a relatively simple operation of inserting the motor into the throttle body, with the support member previously attached to the motor casing, so that the motor casing installation operation is facilitated.

[0016]

Further, it is advantageous for step b) to include supporting the other axial end portion of the motor casing resiliently on the throttle body also with respect to the axial direction of the motor casing via the second support device.

[0017]

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects, features and advantages of the present invention will be readily understood after reading the following detailed description together with the claims and the accompanying drawings, in which:

Fig. 1 is a cross-sectional view of a throttle control device according to an embodiment of the present invention;

Fig. 2 is a vertical sectional view of the throttle control device of Fig. 1;

Fig. 3 is a side view of the throttle control device, with its cover removed; and

Fig. 4 is a sectional view of the throttle control device taken along a line IV-IV of Fig. 3.

[0018]

DESCRIPTION OF THE PREFERRED EMBODIMENT

A throttle control device according to an embodiment of the present invention will be described with reference to the drawings. First, the throttle control device will be described in general. The throttle control device of this embodiment is formed as an electronic-control type throttle control device for controlling the throttle valve opening in response to signals from an engine control unit (ECU) of an automobile (not shown), including, but not limited to signals such as an acceleration signal related to an accelerator pedal depression amount, a traction control signal, a constant-speed traveling signal such as from a cruise control device, and an idling speed control signal.

[0019]

Referring to Figs. 1 and 2, the throttle control device of this embodiment is equipped with a throttle body 1. The throttle body 1 is equipped with a main body portion 20 and a motor housing portion 24, which may be formed as an integral unit using resin. As shown in Fig. 2, formed in the main body portion 20 is a substantially cylindrical intake passage 1a extending vertically as viewed in the Fig. 2. Further, in Fig. 2, an air cleaner (not shown) is connected to an upper portion of the main body portion 20, and an intake manifold 26 is connected to a lower portion thereof.

[0020]

In the main body portion 20, there is mounted a metal throttle shaft 9 radially extending across the intake passage 1a (See Fig. 1). As shown in Fig. 1, bearing portions 21 and 22 through the intermediation of bearings 8 and 10 rotatably supports end portions 9a and 9b, respectively, of the throttle shaft 9. A throttle valve 2, made of resin for example, is fixed to the throttle shaft 9, possibly by means of a plurality of rivets 3 as shown. The throttle valve 2, which is situated inside the intake passage 1a, rotates so as to close the intake

passage 1a as the throttle shaft 9 rotates in one direction, and rotates so as to open the intake passage 1a as the throttle shaft 9 rotates in the other direction. These incremental opening and closing movements of the throttle valve 2 controls the amount of intake air flowing through the intake passage 1a. In Fig. 2, the throttle valve 2 is in a fully closed position. When the throttle valve in the fully closed position is rotated counterclockwise, as viewed in Fig. 2, the intake passage 1a is opened.

[0021]

A plug 7 for confining the end portion 9a within the main body portion 20 is fitted into the bearing portion 21. Bearing portion 21 supports one end portion 9a (the left-hand end as seen in Fig. 1) of the throttle shaft 9. The other end portion 9b (the right-hand end as seen in Fig. 1) of the throttle shaft 9 extends through the bearing portion 22 and protrudes further to the right. A throttle gear 11 consisting of a sector gear is fixed to the protruding end of this end portion 9b so as not to allow relative rotation. A spring force, such as a torsion coil spring 12, is provided between the outer peripheral portion of the bearing portion 22 of the throttle body 1 and the outer peripheral portion of the throttle gear 11. This torsion coil spring 12 always urges the throttle valve 2 so as to close it through the throttle gear 11 and the throttle shaft 9. Further, although not shown, provided between the throttle body 1 and the throttle gear 11 is a stopper for preventing the throttle valve 2 from rotating in the closing direction beyond the fully closed position.

[0022]

As shown in Fig. 1, the motor housing portion 24 of the throttle body 1 is formed in a cylindrical configuration having an axis substantially parallel with an axis 9L of the throttle shaft 9. One axial end (the left-hand end as seen in the drawing) of the motor housing 24 is closed. The interior of the motor housing portion 24 defines a space 24a open on the right-

depression 24b of the motor housing portion 24 of the throttle body 1. Thus, utilizing its radial resilient deformation, the resilient support member 6 is closely fitted onto the outer peripheral surface of the motor end portion 28a of the motor casing 28 of the motor 4. Thereafter, the motor 4 is inserted into the motor housing portion 24 of the throttle body 1, and the motor end portion 28a of the motor casing 28 is inserted into the stepped circular depression 24b of the motor housing portion 24 together with the bearing case 28b. At this time, the support member 6 undergoes radial resilient deformation, and is closely fitted onto the inner peripheral surface of the circular inset portion 24b1 of the stepped circular depression 24b. As a result, the motor end portion 28a is supported by the motor housing portion 24 via the support member 6 resiliently with respect to the radial direction (See Figs. 1 and 4). Further, the support member 6 is resiliently deformed (compressed) in the axial direction (left and right directions as seen in Figs. 1 and 4) between the end surface of the motor casing 28 and a step portion 24b2 extending radially inwards from the circular inset portion 24b1 (See Fig. 4). In this state, as described above, the mounting flange portion 29 of the motor casing 28 of the motor 4 is fastened to the motor housing portion 24, for example, by means of a pair of screws 5 for fixation (See Figs. 3 and 4).

[0025]

Even though the depression of 24b (as well as 24 b1) is described as substantially circular, the current invention is not limited to this one geometric description. Practitioners skilled in the art will recognize that a variety of shapes can be used to provide similar results. It is preferable to use substantially circular depressions and insets in the current invention in order to take full advantage of ring shaped support structure.

[0026]

The output shaft 4a of the motor 4 protrudes to the right as seen in Fig. 1 beyond the

mounting flange 29, and a motor pinion 32 is fastened to this protruding portion (See Fig. 3). Further, as shown in Fig. 1, a counter shaft 34 is mounted to the throttle body 1 at a position between the main body portion 20 and the motor housing portion 24. The counter shaft 34 extends parallel to the axis 9L of the throttle shaft 9. A counter gear 14 is rotatably mounted to the counter shaft 34. The counter gear 14 has two gear portions 14a and 14b having different gear diameters. The large diameter gear portion 14a is in mesh with the motor pinion 32, and the small diameter gear portion 14b is in mesh with the throttle gear 11 (See Fig. 1). The motor pinion 32, the counter gear 14, and the throttle gear 11 constitute a speed reduction gear mechanism 35.

[0027]

As shown in Fig. 1, a cover 18 mainly covering the speed reduction gear mechanism 35 is connected to the right-hand side surface of the throttle body 1 by a coupling means (not shown), for example, a coupling means may include a snap-fitting means, screw means, or clamp means, among others. Between the right-hand side surface of the throttle body 1 and the cover 18, there is provided an O-ring 17 to maintain these components in a sealed state. Further, the motor 4 has a motor terminal 30 protruding from the mounting flange 29, and this motor terminal 30 is electrically connected to a battery (not shown) and, further, to the ECU by way of a relay terminal (not shown) of a relay connector 36 provided in the cover 18. Thus, the motor 4 is driven in accordance with an acceleration signal related to accelerator pedal depression amount, a traction control signal, a constant-speed traveling signal, and an idling speed control signal, etc. The driving force of the motor 4 is transmitted to the throttle shaft 9 through the speed reduction gear mechanism 35, that is, through the motor pinion 32, the counter gear 14, and the throttle gear 11.

[0028]

restricted to the one described above. It is possible to adopt various other constructions therefor.

[0035]

Further, as the means for fixing one end portion of the motor casing 28 of the motor 4 to the throttle body 1 in a cantilever-like fashion, it is also possible to use many different fastening means other than the screws 5, some examples are bolts, nuts, or rivets. Further, there are no particular restrictions regarding the specification of support member 6 as long as it is a resilient, ring-shaped member. The sectional configuration of the support member 6 is not limited to the elliptical one shown; some of the many additional sectional shapes include round and rectangular ones. Further, instead of a ring that is circumferentially continuous, it is also possible, for example, to utilize a plurality of ring segments arranged circumferentially at intervals.